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AN ELEMENTARY TREATISE ON DIFFERENTIAL EQUATIONS AND THEIR APPLICATIONS. By *H. T. H. Piaggio.* London: G. Bell and Sons. Pp., xvi, 216, xxv. Price, 12s. net.

There are many physicists and engineers today, who have often longed for a short and readable treatise on Differential Equations; but who have found themselves repelled by the ponderous and academic volumes that have been produced hitherto upon the subject. Dfferential Equations, as it were, have up till now existed but for the mathematician, and have been jealously guarded by the exhaustive nature of the treatises published. Prof. Piaggio has supplied this long-felt want. In his work we have, condensed into approximately two hundred pages, an account of Differential Equations, suitable for those with no previous knowledge of the subject, and yet amply sufficient to cover the course required for an Honours degree. One feature of the book which especially appeals to us is the superabundance of excellent examples, to which are added explanations of their physical significance. The engineer will be as delighted to find how soon he can understand the phenomenon of resonance (p. 36), as will the physicist to find himself (on p. 48) solving the differential equations used by Sir J. J. Thompson in a recent important contribution to the *Philosophical Magazine*. The miscellaneous examples at the end of the book with their interesting notes—as, for example, on the Zeeman effect, on Hamilton's dynamical equations, or on Einstein's equations of Planetary Motion—will be especially welcome. Graphical methods and Numerical Approximations form an important feature of the book and are quite up-to-date, including methods hitherto unpublished. In conclusion, we congratulate the author on producing a book which is concise without being obscure, and scholarly without being academic.

J. E. J.

THE ORGANIZATION OF THOUGHT, EDUCATIONAL AND SCIENTIFIC. By *A. N.* Whitehead. Pp. viii, 228. London: Williams and Norgate. Price 6s net.

This book consists of reprints of seven addresses and other papers together with one article which has not been published before. The first five chapters deal with education, and are: "The Aims of Education—a Plea for Reform," Presidential Address to the Mathematical Association in 1916 (pp. 1-28); "Technical Education and Its Relation to Science and Literature," Presidential Address to the same Association in 1917 (pp. 29-57); "A Polytechnic in Wartime," an Address given in 1917 (pp. 58-68); "The Mathematical Curriculum," Presidential Address to the Mathematical Association in 1912 (pp. 69-91); and "The Principles of Mathematics in Relation to Elementary Teaching," a paper read to the International Congress of Mathematicians at Cambridge in 1912 (pp. 92-104). The remaining three chapters contain discussions on certain points arising in the philosophy of science, and are: "The Organization of Thought," Presidential Address to Section A of the British Association in 1916 (pp. 105-133); "The Anatomy of Some Scientific Ideas" (pp. 134-190); and "Space, Time, and Relativity," a paper read to Section A of the British Association in 1915 and afterwards to the Aristotelian Society (pp. 191-228). Of these chapters the second, sixth, and eighth have been already noticed at some length in the MONIST; thus we will here confine our attention to the remaining five essays. It must be remembered a common line of reflection runs through the whole book, and the two sections influence each other (p. v).

The two commandments to be obeyed in any educational scheme are: Do not teach too many subjects, and what you teach, teach thoroughly (p. 3). In training a child to activity of thought, we must beware of ideas that are merely received into the mind without being utilized or tested or thrown into fresh combinations (p. 4). Such "inert ideas' have overladen schools of learning at certain periods, and the above commandments indicate the way to guard against the "mental dry rot" that these inert ideas produce (p. 5). "The result of teaching small parts of a large number of subjects is the passive reception of disconnected ideas, not illumined with any spark of vitality. Let the main ideas which are introduced into a child's education be few and important, and let them be thrown into every combination possible. The child should make them his own, and should understand their application here and now in the circumstances of his actual life. From the very beginning of his education, the child should experience the joy of discovery. The discovery which he has to make is that general ideas give an understanding of that stream of events which pours through his life, which is his life. By understanding I mean more than a mere logical analysis, though that is included. I mean 'understanding' in the sense in which it is used in the French proverb, 'To understand all is to forgive all'" (pp. 5-6). The old notion that the mind is an instrument to be first sharpened and then used is "one of the most fatal, erroneous, and dangerous conceptions ever introduced into the theory of education. The mind is never passive, it is a perpetual activity, delicate, receptive, responsive to stimulus. You cannot postpone its life until you have sharpened it. Whatever interest attaches to your subject-matter must be evoked here and now; . . ." (p. 12). "There is only one subject-matter for education, and that is life in all its manifestations. Instead of this single unity, we offer children—algebra, from which nothing follows; geometry, from which nothing follows; science, from which nothing follows; history, from which nothing follows; a couple of languages, never mastered; and lastly, most dreary of all, literature, represented by plays of Shakespeare, with philological notes and short analyses of plot and character to be in substance committed to memory" (pp. 13-14). We ought, for example, to use as examples for graphs in algebra the curves occurring in history and other studies of society (p. 16). "English education in its present phase suffers from a lack of definite aim and from an external machinery which kills its vitality. . . . England halts between two opinions. It has not decided whether to produce amateurs or experts" (pp. 25-26). "The essence of education is that it be religious. . . . A religious education is an education which inculcates duty and reverence. Duty arises from our potential control over the course of events. Where attainable knowledge could have changed the issue, ignorance has the guilt of vice. And the foundation of reverence is this perception, that the present holds within itself the complete sum of existence, backwards and forwards, that whole amplitude of time which is eternity" (p. 28).

In this address is manifested Dr. Whitehead's intense sympathy with that side of teaching in which the technical uses of an abstract science are emphasized; this by no means separates him from the majority of other mathematical logicians. To many, indeed, it seems rather striking that some of the greatest advocates of such "practical" methods of teaching mathematics are to be found among logicians. But what does, it seems, separate Dr. Whitehead from perhaps the majority of the modern school of mathematical logicians is the fact that he emphasizes the great value of the history of mathematics in teaching But the remark in the fourth chapter should be taken to heart: "Another way in which the student's ideas can be generalized is by the use of the history of mathematics, conceived not as a mere assemblage of the dates and names of men, but as an exposition of the general current of thought which occasioned the subjects to be objects of interest at the time of their first elaboration" (p. 81). "Perhaps," he says (p. 82), "it is the very subject which may best obtain the results for which I am pleading."

The fourth chapter is concerned with two sides of mathematical study (general ideas of (1) quantity and number and (2) laws of nature), and also logical method (pp. 78-79, 79-81, 82). Then there is an indication (pp. 83-89) of some stages in an ideal course of geometry "and ideals can never be realized" (p. 89).

The fifth chapter of the book is concerned with the investigation of the place which should be occupied by modern investigations respecting mathematical principles in the education of the majority of boys in secondary schools, and Dr. Whitehead's thesis is (p. 99) that a power of concentrated logical thought "cannot be assumed, and has got to be acquired, and that a mathematical training is nothing else than the process of acquiring it." In this essay, among the memorable sentences which occur so frequently in the book the following strikes the reviewer as particularly important as bringing out that logic is really being taught even in a mathematical course. "When logic begins, definite particular individual things have been banished. I cannot relate logically this thing to that thing, for example this pen to that pen, except by the indirect way of relating some general idea which applies to this pen to some general idea which applies to that pen. And the individualities of the two pens are quite irrelevant to the logical process. . . . Thus the practice of logic is a certain way of employing the mind in the consideration of such ideas; and an elementary mathematical training is in fact nothing else but the logical use of the general ideas respecting geometry and algebra which we have enumerated above" (p. 97).

The seventh essay is not concerned with what scientists in the past meant to achieve, or thought that they could achieve. What is discussed is the natural history of ideas and not volitions of scientists. "There is a twofold scientific aim: (1) the production of theory which agrees with experience; and (2) the explanation of commonsense concepts of nature, at least in their main outlines" (p. 140). In succession the essay deals with facts, objects, time and space, and fields of force. In the third part the relation of whole and part is dealt with in a way that forms a complement to the sixth chapter, and then Dr. Whitehead's well-known construction of a mathematical "point," straight lines and planes, and empty space are shortly dealt with. In the conclusion, ontological ideas are introduced again—they were banished at the beginning of the chapter.

This book, with its emphasis on the fact that mathematics should appear to the student as a living and growing thing, and its wide sympathy with the process of becoming acquainted with abstract things by familiarity with practical applications, is the most welcome and stimulating news that has been received by learners for many years. It is to be hoped that teachers will give due weight to Dr. Whitehead's important contributions. One thing might be added. The way that suggests itself before everything else for arousing interest in a student's mind at the very beginning of work on a mathematical subject is the study of the physical and other practical problems by which the methods were developed. We can imagine no better training for anyone who is trying to get familiar with the calculus than working through the problems devised by Leibnitz and the Bernoullis toward the end of the seventeenth century. Only by such means, it seems, can one get at once an idea of what people who teach presumably mean when they talk about the "great power of the calculus" as compared with Cartesian methods.

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